"A Different Kind of Middleman"

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Preservice Science Teachers' Agency for Climate Change Education

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Introduction

> I still care about climate change a lot and I try to do things to, you know, reduce my carbon footprint as best way that I could because I feel like that's what is going to help. But, in terms of, like—and I am not that into politics that much—I feel as if it's a bigger problem.
>
> Not enough people are thinking about it GLOBALLY and they are more thinking INDIVIDUALLY. And that's why, for me, I feel like I'm more ALONE in it because I feel like I'm the minority who's thinking about the majority, like the global scale. But, I don't think that a lot of people do that.
>
> (Ms. Cassy Crawford, Middle School Science Teacher)

This excerpt from the focal participant of the study reported in this chapter serves to illustrate one of the moral and ethical dilemmas the world has been facing in relation to climate change crisis. On the one hand, people who believe in climate change think that it is rational for every agent to cooperate in taking actions to solve climate change problems. On the other hand, if people act based on their individual interests, it is rational to undermine the problem. Stephen Gardiner (2006) relates this paradoxical situation to the idea of the "Tragedy of the Commons," an article published by the ecologist Garrett Hardin in 1968 in *Science*. Since climate change is an international problem, Gardiner describes nations as the relevant parties "who represent the interests of their citizens in perpetuity" (p. 400). While many countries agree that measures need to be taken to solve the climate change problem, such as restricting greenhouse gas emissions, every nation wants to rely on other countries' actions. In this way, countries are able to protect the individual, often short-term economic and political interests of their own citizens. This creates a paradoxical situation which adds to the complexity of addressing the climate change crisis.

As we are still in debate on how to deal with this paradoxical situation across different communities or nations, climate scientists are calling for urgent action. As of 2018, human-made climate change has

caused a 0.87 degrees Celsius increase in average global temperature over historic averages (International Panel for Climate Change—IPCC). This change has led to drastic impacts on ecosystems and organisms, such as increased acidification in oceans, which challenges oyster larval development, or intense rain in parts of the world and drought in other regions. To further complicate the problem, the most devastating impacts of climate change are unfairly experienced by people who live in poverty. What this means is that climate change is not only an ecological issue, but it is also a political issue with implications for equity and social justice. The recent IPCC report (2018) calls for collective action, such as a 45% decrease in global carbon emissions by 2030 so that we can limit disastrous impacts of climate change.

As two midcareer, international scholars of science education, we observed climate change impacts in different communities across the world, such as heat waves and drought in Europe, and the polar vortex, hurricanes, and wildfires in the USA. These extreme weather events led to destruction of houses, damage to crops and feeders for animals, and even death of humans. We witnessed practical solutions our communities wanted to act on such as creating bike friendly communities, recycling programs, reducing one-time-use plastics, and so forth. Yet, the bigger, global problem still persists. Our work as science education scholars has a focus on teachers as they are critical social agents (e.g., Avraamidou, 2019). Other scholars in the field also explored Preservice Science Teachers (PSTs) as the subject of climate change studies. These studies looked at PSTs' scientific background knowledge to understand the climate change evidence (e.g., Boon, 2010), their misconceptions (e.g., Plutzer et al., 2016), emotions about climate change issues (e.g., Lombardi & Sinatra, 2013), and use of argumentation in scientific practices to improve PST's sensemaking of climate science (e.g., Lambert & Bleicher, 2017).

Previous studies highlighted the potential role of PSTs as agents of taking action to solve the climate change problem (McNeill & Vaughn, 2010). Science educators then raised the question of how PSTs' sense of agency might be enhanced in order to enable them to feel a part of the solution to climate change (e.g., Rivera Maulucci, Brotman, & Fain, 2015). However, there is still a dearth of studies that looked at PSTs' agency in effectively communicating climate change and encouraging people to act on this urgent problem. Therefore, in this chapter, we are interested in exploring PSTs' agency through a single case study of Ms. Cassy Crawford. In this four-year-long study, we were able to trace Ms. Crawford across spaces such as workshops, research meetings, and middle school classrooms, and across time from a junior in college to science teacher at a public school.

What is Teacher Agency and Why Does It Matter?

The study is framed within the construct of "agency" which is generally used to refer to the ways in which teachers might see themselves and be recognized by others as agents of change. In science education, the construct of agency has been conceptualized as a dimension of teacher identity, which refers to "the ways in which a teacher represents herself through her views, orientations, attitudes, content knowledge, knowledge, and beliefs about science teaching, and the ways in which she acts within specific contexts" (Avraamidou, 2014, p. 224). The construct of identity has been mostly framed within cultural-historical activity theory (Engeström, 1999), initially formulated by Vygotsky's idea of activity systems where subjects reach their objects through social interaction with their mediating artifacts. As Roth et al. (2004) argued:

> Social analysis in terms of cultural historical activity theory focuses on what people (subjects) actually do, the objects that motivate their activity, the tools they use, the community of which they are part, the roles that pattern their actions, and the division of labor they take in activity.
>
> (p. 50)

This emphasis on the dialectical relationship between teachers and the contexts in which they develop and enact their identities are of special interest in this study. As Luehmann (2008) argued, the construct of identity is particularly important within the field of teacher education because it offers a comprehensive construct for studying teacher learning and development, which goes beyond knowledge and skills:

> The sole focus on knowledge, understanding or other purely cognitive constructs in teacher education, has been criticized as limited as it leaves the novice teacher alone to figure out how to develop, integrate, and reconcile emotions and physical aspects with the understandings involved in becoming a teacher.
>
> (p. 827)

Beyond the emphasis on the affective domains of teacher learning and development, the sociocultural nature of identity is also important for the purpose of conceptualizing agency because it highlights the value of paying attention to the social contexts and communities in which teachers learn, develop, and act. As Shanahan (2009) argued, agency refers to each individual's ability to shape the world around them. Our interest on agency goes beyond understanding what agency is to also include what agency looks like in practice. Hence, we focus our attention on characterizing the participant's practices. This is rooted in Biesta and

Tedder's (2007) ecological conceptualization of agency, which places emphasis on its enactment:

> [T]his concept of agency highlights that actors always act by means of their environment rather than simply in their environment [so that] the achievement of agency will always result from the interplay of individual efforts, available resources and contextual and structural factors as they come together in particular and, in a sense, always unique situations.
>
> (p. 137)

The construct of teacher agency remains largely unexplored in science education research with only a few notable exceptions. For example, Moore (2008) examined how teachers' identity and agency were connected, influenced, and shaped by each other. In a study with a group of 23 preservice elementary teachers, she examined how elementary preservice teachers' conceptions as "agents of change" shape their identities and agency as science teachers, and the ways in which their perceptions as change agents frame their understanding of teaching science for social justice in urban elementary classrooms. The participants of this study enrolled in a 16-week science methods course in the northeastern United States. Data consisted of the participants' reflections from a semester-long Book Club in which they participated and two diversity surveys (before and after the Book Club). In this Book Club, the preservice teachers read the book *Ways with Words* and met in class three times in small groups to discuss questions about the book, issues of diversity, teacher identity, and science teaching. Five of these teachers also participated in semi-structured interviews at the end of the semester where they were asked questions about their positional identities. The analyses of these data revealed how identity and agency connect, influence, and shape each other as preservice teachers become agents of change in elementary science classrooms. These findings highlight the need to address agency and science teacher identity in supporting preservice teachers in learning to teach science for social justice.

Another example of research that explores agency is found in Richmond's (2016) study which explores the interplay between professional identity and contextual factors and how those contribute to a sense of agency. In this work, using interviews, journals, course and field assignments, and related artifacts, the author reports on efforts to elucidate how PSTs preparing to work in high-poverty schools in the United States make sense of their multiple contexts, and how this sense-making shapes their professional identity and agency as science educators committed to working in challenging settings on climate change topics that offer unique challenges due to their assumed controversial, interdisciplinary, and complex nature. In this, Richmond shares what she calls

"re-constructed" narratives, comprised of first-, second-, and third-person narratives that are constructed from a variety of data sources collected during the participants' final two years of the teacher preparation program. The purpose of these reconstructed narratives, as Richmond argues, is to illustrate, and at the same time problematize, the relationship between agency and identity, and point to ways in which various kinds of contexts can serve to help move an individual's identity as a teacher forward or can serve as obstacles to growth. Essentially what the findings of this study show is: (a) the consonance between the professional identity one sculpts and the agency one has for making intentional moves likely to have positive outcomes is critically important for creating the conditions for success, in the immediate present and into the future; and (b) contextual factors matter, not only for that sense of agency to develop initially, but to be maintained. The ways in which identity intertwines with agency and how contextual factors might shape agency are at the heart of the account of this study in the context of climate change.

Preservice Teacher Agency from an Ethical and Moral Lens for Climate Change Education

Our fields are starting to recognize PSTs' potential to be the critical agents in engaging the public to act on solutions towards climate change. Due to their close connections to the next generation and the many years of teaching ahead of them, each PST has the potential to create an immense impact on K-12 students. According to Lawson et al. (2019), these K-12 students can then impact the views and even actions of their parents. By working with 238 families in coastal North Carolina, Lawson et al. found that children who developed more concern towards climate change through new instructional strategies also impacted their parents such that their parents had significantly increased concern for the climate change problem. Interestingly, they found that the impact was higher among families who had initially refused to engage in climate change related issues. Therefore, the impact of PSTs' practices might extend beyond their students, and potentially influence their parents as well as stakeholders. In what follows, we examine the ethical and moral reasons and dilemmas that PSTs might experience during the process of developing a sense of agency.

What Leads to Preservice Teachers' High Feeling of Agency to Teach Climate Change?

We will draw from two recent theories to show why some PSTs develop a high feeling of agency for teaching climate change, particularly when they are engaged in working with K-12 students. One is a few decades old

theory of "the ethics of care" (Gilligan, 1982; Held, 2006; Noddings, 1984). The ethics of care looks at the relationship between two parties: one is the carer and the other is cared for (Buber, 1965). This theory suggests a moral dimension that the carer is responsible for listening and attending to the needs for the cared for (Noddings, 2012). By using ethics of care, scholars explored the relationships between teacher as the carer and the students as the cared for (e.g., Noddings, 2012) or the human as the carer for the place (the environment) as the cared for (e.g., Schindel & Tolbert, 2017). Despite highlighting a moral responsibility in relationships, the ethics of care scholars are against the common views of traditional moral theories that aim to eliminate bias, personal values, and emotions from their claims. Hence, the ethics of the care view acknowledges personal or family stories and moral emotions, such as empathy and sensitivity, to examine what shapes reasoning and decision making (Held, 2016).

Both human–human and human–nonhuman relationships might relate to how PSTs see themselves as important agents in climate change education. As future teachers, they learn to care about their students and feel the moral responsibility to raise climate literate generations who can make decisions for the world they will be living in. PSTs might feel the moral responsibility for youth to be prepared for living in an environment where worsened climate impacts are highly possible. This statement assumes that youth need help to deal with climate change problems in the future. Ethics of care scholars argue that there is a difference between "assumed" vs. "expressed needs" by the cared for (Noddings, 2012, p. 773). It is necessary that the students' need should be expressed in interactions with teachers and that PSTs listen to their students' needs. Moreover, the ethics of care perspective can help us understand how students can engage in climate change learning thanks to the relationship between PSTs (and their students) and the environment. In this case, PSTs and their students are the carer, and the environment or the local place is in need of protection from climate change impacts. In their study, Schindel and Tolbert (2017) found that a male science teacher's explicit carework for the place led his students to positively connect to nature and to their teachers. Moreover, their study emphasized that the teacher's carework better engaged marginalized students in formal school work.

Another theory we see as influential in PSTs' feeling of agency for the climate change problem is the theory of intergenerational equity. This theory considers that the right of future generations to inherit the planet in "at least as good condition as every other generation receives it and to be able to use it for its own benefit" (Weiss, 2008, p. 622). The theory of intergenerational equity runs on three major principles: (a) conservation of options that requires the future generation inheriting the same diversity of natural resources as we have now; (b) conservation of quality suggests that the Earth will not be in a worse condition for future

generations; and (c) conservation of access recommends that different populations on Earth will have fair access to nature's resources (Weiss, 1983, 2008).

We view PSTs as being at the center of a social justice issue of intergenerational phenomena in acting on the climate change problem. Gardiner (2006) sees this intergenerational aspect of climate change as a bigger problem than the "Tragedy of the Commons" problem that nations face due to dilemmas about global vs. individual interests. This is because we have no other option but to come into an agreement with the generations before us who initiated many of the drivers of climate change, or future generations who might experience the worst impacts. Scientists have been in strong agreement that the excess amount of atmospheric CO_2 has been the major driver of climate change. CO_2 can stay in the atmosphere close to 200 years (Archer, 2005). Due to this long life, it makes it harder to reverse this backloaded problem for future generations. Moreover, it is often hard to understand the impacts of climate change. For example, sea level rise is a process that plays out over decades, or even centuries. As a result, leaders with short-term horizons will have a hard time responding to these threats. These threats will be worse for the disadvantaged regions of the world if our generation does not develop guidelines or laws for conservation of access for future generations (Weiss, 2008). As opposed to working with people whose concerns are the urgent problems of our generation, PSTs have an advantage of working with the students who are closer to the next generation and might have more concerns for the quality and options of resources that will be inherited by these next generations. Working with youth can inspire PSTs as they think of themselves impacting future generations; and this expands their horizons.

From a High Feeling of Agency to Taking Action: What Do Preservice Teachers Need?

A review of the literature provides evidence that a feeling of agency is necessary for taking action; however, a feeling alone is not sufficient to initiate action (Haggard & Tsakiris, 2009). Instead, a high feeling of agency can lead to individual action only if the social structures are in place and the trust is established for the actors in positions of power, such as scientists and politicians, so that they are willing to solve the climate change problem on a broader scale (Tayne et al., 2021; Walsh & Cordero, 2019). Similarly, PSTs might have a high feeling of agency; however, they often do not have enough opportunities to develop identities to take on the challenge of teaching climate change once they become a practicing teacher. *Climate Change and Sustainable Development: The Response from Education* (Læssøe et al., 2009) blames the inadequacy of preservice teacher education programs as the reason for the lack of

effective climate change education. In this regard, some studies focused on threading the climate change issue through methods courses (e.g., Matkins & Bell, 2007) and emphasizing the moral and ethical issues related to climate change (Hestness, McGinnis, Riedinger, & Marbach, 2011). Matkins and Bell (2007) found that teachers who were exposed to a climate change unit were more likely to integrate climate change in their future classrooms.

Carter (2012) draws attention to the complexity of preservice teachers' engagement in climate change issues due to their still developing sense of their own professional identities as becoming a teacher. To add to this complexity, studies found that preservice teachers focus on individualistic solutions to climate change while not highlighting collective actions towards solutions to it. This was the issue that Ms. Crawford highlighted in a recent interview (see opening quotation). A study by Kenis and Mathijs (2012) found that young adults might not see such individual behavior as effective, but continue to do it as they might not know how to work towards systemic, collective efforts. This raises an ethical issue as teachers are constrained in their ability to contribute to large institutional or infrastructural efforts to take action. The sociopolitical context of recent years limits the contributions to climate change adaptations to only a few, while educators from high poverty neighborhoods do not typically have access to work towards these broad scale solutions (Walsh & Cordero, 2019).

Another burden PSTs need to shoulder is working with students in uncertainties involved in climate change claims. Despite the certainty on what causes climatic changes, the uncertainties remain regarding its future impacts, making it harder for novice teachers to make sense of climate change and to attend to students' questions. Although climate scientists have a consensus on human-caused climate change (Cook et al., 2016), there remains the "scientific uncertainty about the precise magnitude and distribution of effects" (Gardiner, 2006, p. 401). Therefore, it will be hard to infuse these uncertain ideas into the dynamics of a traditional science classroom environment that prioritizes facts and accurate findings from canonical science. These uncertainties can put PSTs in vulnerable positions as they are learning to promote students' epistemic agency, that is, students' participation in knowledge construction through scientific practices in their classroom (Damsa, Kirschner, Andriessen, Erkens, & Sins, 2010; Stroupe, 2014). The increased student epistemic agency in science classrooms has been recently emphasized by scholars in the USA (e.g., Miller et al., 2018; Stroupe, 2014) who view it as a necessary move for meaningful engagement in scientific practices as suggested by the most recent standards (NGSS, 2013). Examples of how PSTs can promote students' epistemic agency are recognizing students' background or local knowledge (Campbell, Schwarz, & Windschitl, 2016), designing activities where

students collect their own data and make decisions about the validity of this data, formulating scientific questions, and designing investigations to respond to these questions (Miller et al., 2018; Sezen-Barrie et al., 2020). While working with climate data and claims and being active epistemic agents, students will explicitly notice the uncertainties. PSTs will need to navigate students' perspectives regarding uncertainty, which is an ethical dilemma considering the current public denial over climate change action (Gardiner, 2010). Furthermore, the current model of STEM education in many schools requires science teachers to work on already established claims with high scientific certainty (Plutzer & Hannah, 2018). This model might limit PSTs to working on recent questions about climate change impacts, mitigation, and adaptation, or give students opportunities to raise their questions.

Our aim with the study reported in this chapter is to contribute an in-depth exploration of how a PST, Ms. Crawford, conceptualizes her sense of agency in relation to climate change. We do so through an exploration of her learning and teaching of climate change in multiple contexts across time: middle-school classrooms, professional learning environments, family gatherings, and climate change education research meetings.

Modes of Inquiry

For the purpose of the study we used an ethnographic perspective where the participant observations and iterative cycles of ethnographic interviewing have been utilized (Spradley, 2016). We intentionally selected Ms. Crawford as a potentially illustrative case from which we can unpack the affordances and tensions a dedicated preservice teacher might have in developing a sense of agency in contributing to solving the problem of climate change. We also looked at intertextualities (Gee, 2014) among interview data and teacher and student produced artifacts to make sense of the reason for changes in the conceptualization of agency (Strauss & Feiz, 2013).

Focal Participant and Her Relationship with the Research

The study has the characteristics of a single case study (Stake, 2010) as an exploration of a phenomenon (i.e., teachers' development of agency) through detailed, in-depth data collection involving multiple sources of information rich in context (Creswell, 2007). The value of a single case lies in the opportunities for readers "to experience vicariously unique situations and unique individuals" (Donmoyer, 1990, p. 193). Focusing on only one participant allowed for deep and detailed explorations of the complex processes and dynamics of the development of her sense of agency as well as the factors that were critical to the development of her agency.

This single case study is a part of a larger, five-year-long National Science Foundation (NSF) funded project, which aims to improve and assess climate change education at K-16 classrooms. As a part of this project, scientists, education researchers, and teachers work together to prepare Climate Literacy Workshops (CLWs) for preservice teachers. CLWs aim to strengthen preservice teachers' conceptual and epistemic sensemaking of the science behind climate change as well as to provide rigorous and responsive teaching tools. CLWs had two main parts: (1) a one-day-long workshop to introduce teachers to the core concepts and epistemic ideas of climate change; (2) preservice teachers' implementation of a climate change unit in a middle school classroom. Ms. Crawford was recruited for a CLW while she was a junior student in the first author's (Asli Sezen-Barrie's) Earth and Space Science course. At the time, she had 18 months remaining to finish her degree from a large mid-Atlantic University in teaching science and math in middle school classrooms (4–8th grade). Crawford was then chosen intentionally for this case study because of (1) her background experiences related to climate change impacts; (2) her preparation on reform based, responsive science teaching at middle schools; and (3) her dedication to learn and teach climate change in middle schools.

Crawford is a white female, who grew up in New Jersey, a state that was heavily impacted by "Superstorm Sandy" in 2012. During this time, Crawford volunteered to work at her hometown to tutor kids whose houses or schools were flooded. Since then, she gained interest in taking part in climate change solutions because she "doesn't want future generations to experience negative impacts of climate change."

Context and Data Collection Process

The primary data for this study came from approximately 50-minute-long pre-, mid-, and post-interviews, conducted at the beginning of the study, after participating in the climate change education project, and after Ms. Crawford had been teaching science at a public school for two years. The study also utilized secondary data sources such as written reflections, lesson plans, student artifacts, and impromptu ethnographic interviews. These data were collected throughout a period of four years and at different learning and teaching contexts (see Figure 6.1).

Once Crawford was recruited for the study, we participated in an approximately 50-minute-long pre-interview. During September 2016, Crawford attended the one-day-long CLW. She then worked with a scientist, science educator, and a public middle school teacher to develop a four-day-long mini-unit around an activity, "It's a Gassy World." This was designed to introduce middle school students to the relationship between carbon dioxide (CO_2) and the warming of the Earth's surface (global climate change). In this activity students work toward answering

the driving question: "Will warming oceans be better or worse at soaking up CO_2?" As students worked on this question, they gained experience engaging in scientific practices by designing an experiment to explore how temperature affects water's ability to retain CO_2. Students were challenged to analyze and interpret the results of their experiment, and connect their findings to global patterns of climate change. During the main exploration, students were guided to measure how much CO_2 will be released from cold vs. warm ocean water. Alka-Seltzer tablets were used to add CO_2 to ocean water and balloons were used to capture the releasing CO_2. Students designed three trials of the experiments and chose their own measurement methods for the volume of the balloons (such as using a string to compare the diameter).

Crawford was later mentored by an experienced middle school science teacher, Ms. Buck, for the implementation of the activity in a middle school classroom. For her preparation, Crawford had to observe students multiple times to make contextual adjustments. During her week-long implementation, she wrote daily reflections about her practice. She also collected students' artifacts, including investigation design protocols, findings from the investigations, and Know-Learn-Evidence-Wondering charts in relation to the driving scientific question.

After this experience, Crawford decided to be part of the climate change education project group as a research assistant. As a research assistant, she participated in studies with experienced teachers. She helped with the implementation of activities for professional learning sessions and took part in writing research studies. She provided reflections on her readings and research meetings.

When Crawford graduated, she was hired as a science and math teacher at a local public school. During this time, she did not teach a unit on climate change education, but she took responsibility to lead the Green Team at her school. This was charged with finding and acting on solutions to environmental problems. As a team, they worked on STEAM (Science, Technology, Engineering, Arts, and Mathematics) nights and presented a year-long project on reusing cafeteria cups to build bird feeders. They also won a grant to collect mascara pens for cleaning oil spill from birds' wings to send to a pro-environmental organization.

Data Analysis Approach

We started our data analysis by organizing our interviews into transcripts as sociolinguistic tools that will help us identify how Crawford expressed her sense of agency, what subjects she used (herself, family members, future teachers, future scientists, new teachers), and what reasons/factors shaped her agency (Gee, 2014). First, we scanned through the transcripts and secondary data sources for macro-analysis of what, or if there was a, change in Crawford's sense of agency. Once we noticed that the
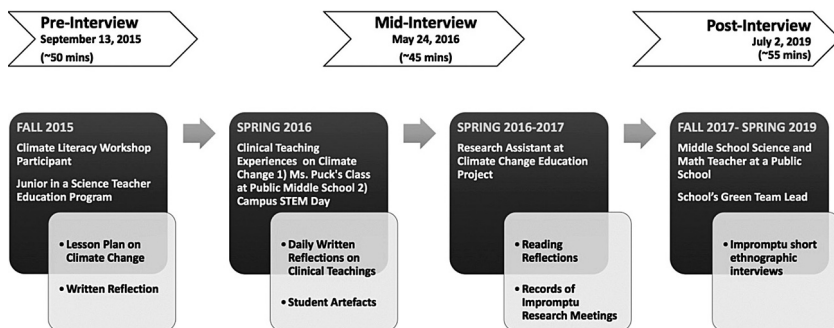
Figure 6.1 Primary and secondary data sources and related contexts.

change mostly occurred when she identified herself as a future teacher, we highlighted these excerpts in the transcript, as shown underlined in Table 6.1. We described the change in agency and identified a category for aboutness (e.g., scaffolding scientific practices). These categories have been iteratively revised by looking at intertextualities across secondary data sources and until two researchers reached 100% agreement.

Findings

Despite Crawford's strong agency to be part of the solution to climate change, she had a moderate sense of agency when she thought of herself as a future teacher. We witnessed changes in her sense of agency as a future teacher after her clinical teaching experiences in a middle school, and after participating in the climate change education project. We noticed that this change continued once she was hired as a science teacher and had her own classroom. In this section, we will first talk about the reasons behind her moderate sense of agency. We will then elaborate on the factors that led to change in her agency. Finally, we will talk about the constraints for her improved sense of agency.

Reasons for Initial Moderate Sense of PST Agency

At the beginning of this study, Crawford saw her role in the solution to climate change as "the middleman" who would learn the information about climate change and "give" this information to students. She was worried, however, that she would have challenges achieving this goal as a teacher. Below are the three reasons we identified across multiple data sources for the moderate sense of agency as a future educator.

Table 6.1 Sample representation from the data analysis process

Pre-interview transcript	Mid-interview transcript	Change in agency	Aboutness
I think I would be like especially in middle school it might be one of the first times that they're hearing about it. So I'll be the first person to provide solutions to them, which I think is a really cool role, also like educating them on what's happening. I like when students get to learn about real world events so having them – my role would be like having them current up-to-date with what information's really going out, going on out there right now. So being like <u>the middleman between what is happening and the students, I'll be like the information middleman because I'll be still educating myself just as much as the students will be getting educated, too.</u> Like I plan on staying current with it so …	I feel like even though maybe yes <u>as a middleman</u>, but I still was able to … like I might've been the middleman, but I was standing on the outside of the circle. Like I facilitated but the <u>students were the ones really learning for themselves, which I thought was coo</u>l. So I set it all up for them, but then they got to dive in and <u>figure it out for themselves</u>. Like I asked the class at the end like so what do you guys think? I asked like the driving question. They were able to tell – like I didn't really tell them, but they were able to tell me that the warm water releases more CO_2 and I was like oh, thank God. <u>Did I see myself as the middleman? Yes but in a completely different way than I originally would've thought I would've felt.</u>	Ms. Crawford's agency as "the middleman" has changed from an information transmitter to "the middleman – in a completely different way" that is a guide helping middle school students figure out climate change evidence.	Experience teaching science as practice – Scaffolding scientific practices **Secondary Data Sources** Clinical Teaching Experience –Written reflections

Scale of the Population

During a reflection session following a climate change workshop, Crawford talked about the idea of becoming an environmental scientist instead of a teacher. Although she was successful at her teacher education program, she thought such a transition could help her to talk about climate change at "a larger scale":

> I think maybe talking to people on a larger scale or even, like I said before, like debating with the people who—like you know how like there's environmentalists against like the pipeline and stuff that's going on? Like I would be able to inform a larger public.

She thought that, in that context, she could have a higher impact and inform a larger portion of the public about issues of climate change.

Time Allocated

Crawford was also worried that there would be less time allocated for talking about climate change in her classroom:

> Oh, just like a bigger public or doing—so with teachers, right, like the climate change, like the days they're allowed to spend on climate change isn't that long. But if I have a job as an environmentalist and whatnot, I'll be doing that all year round, not just a few days out of the week or maybe just a week, so I'd be able to focus on it for a longer period of time.

Because of this limited time allocated to climate change in K-12 classrooms, Crawford didn't expect that she would be able to focus on climate change as much as she would have liked.

Type of Conversations

Another major reason for Crawford's moderate sense of agency as an educator was the difference in the type of conversations she could have as a scientist vs. as a teacher:

> And I enjoy having those intelligent conversations with someone like him [scientist] as to how he can help, like save the environment a little bit more but at the same time like still have a job, you know? With my students, I might not be able to, you know, have those dense conversations.

What becomes evident in this excerpt is that Crawford thinks that while she can have "intelligent conversations" with a scientist, these conversations would not be as "dense" with her students.

Factors Leading to an Improved Sense of Agency

After her involvement in the climate education project and clinical teaching experiences at Ms. Buck's middle school classroom, Crawford's sense of agency as a future educator was different in nature and much stronger. She said she still sees herself as the "middleman" but in a "completely different way." In her words, this completely different middleman felt a stronger agency in the classroom where she "facilitates" students "who really care." Below we will discuss two factors we identified that explain this difference in the feeling of agency.

Scaffolding of Scientific Practices

Teaching science as a practice has been a focus in the most recent science standards, Next Generation Science Standards (NGSS, 2013). However, science education scholars argue that enabling these standards requires creating opportunities for increased student epistemic agency (Miller, Manz, Russ, Stroupe, & Berland, 2018; Stroupe, 2014). This agency is the active participation of students during scientific knowledge (re)construction in classroom activities where their ideas are valuable in deciding on, for example, designing investigations and choosing their claims. Seeing what happens in a classroom when students had epistemic agency made Crawford rethink her sense of agency as an educator. In the following excerpt, right after a teaching clinic with Ms. Buck, Crawford talked about how she saw the excitement in the class when students were engaged in doing "the whole experiment," that is when they designed the experiment themselves:

> I felt like I was actually like doing something. Like sometimes I go to internship and I'm not like—I feel like I'm not always impacting them or getting like the aha! moments a lot because they don't like to do a lot of work. But like as soon as like the first group was like ahead of the other groups. And as soon as the one kid dropped in the Alka-Seltzer and did the whole experiment, they were like, "Whoa!" and instead of just being like all right, let's take notes and move on, they were like "Can we do it again?" And I was like if we have the seltzer tablets for it, yeah. So, I think seeing them so engaged and seeing them so like into it, you know, so I thought that was really cool. They were all really nice there.

When Crawford noticed students' engagement in the scientific practice in their decisions and ideas, she thought it was "really cool." After two years, when reminded of this observation, Crawford said:

> I think that while giving them [my students] epistemic agency, you know how I said how I feel like I am the middleman, I see them

becoming the middleman. Because we have like morning announcements … We branch off into teams and at the end of the meeting as students are like, all right, let's write a script and try to get this on air. So, we can communicate to the school about the ones, and even like any initiative that we've done. We did the bird feeder one like collecting the bottles. We did like a tip of the week and so students would go on once a week, they would like during our meetings we had the TV crew film them and it would be their responsibility to look at tips.

After working with her own students on various pro-environmental projects, Crawford identified an intergenerational impact of her role. Each of her students cared about these issues like herself and are, themselves, becoming "middlemen" who will help communicate the climate change problem to other people.

Ethics of Care: Youth

Scholars have highlighted ethics of care as an important framework to look at people's decision-making processes (Gilligan, 1993; Noddings, 1992; Tronto, 2013). Studies highlighted that students who care about what they learn may better engage in school and show more academic success (Dance, 2002; Valenzuela, 1999). Noticing the care middle school students showed was significant in Crawford's decision to pursue a career as a teacher and feel that she can be an agent towards a solution to climate change. Following the completion of her clinical teaching experience on climate change, Crawford said:

I feel very optimistic about the country's youth because I feel my parents or my grandparents couldn't care less about it because they know that they can't—they're not gonna make enough of a difference in their lifetime for them to see the change, for it to reverse back or whatever. And, then my parents are kind of like: yeah, I mean it's there but I'm too small. I can't contribute.

After two years of having her own students, Crawford continues to feel that many family and friends around her show little concern about climate change. However, as a teacher, she is still "optimistic" about the youth, the middle school students who care to work on climate change projects. In the following, she explains what her impact will be by working with these students who care:

I probably had 170 students this year. So, I, in some way, impacted 170 students now, even if they just tell one person 170 times, that makes 340. And then after this year, I probably impacted 340 plus whatever students that I am going to get this upcoming year. So, I

feel, in terms of impact, if you look at it from like a graph stand-point, it should go up like from year to year, as people continue to maybe have me as their teacher or someone who is passionate about solving the climate change problem. Hopefully, those graphs will go up exponentially.

Challenges to Improved Sense of Agency

While Crawford's sense of agency as an educator is stronger, there remain some challenges which make her consider moving into a career as an educational researcher instead of a public school teacher.

The Isolated Nature of the Curriculum

One of the challenges is the current design of the curriculum at her school. Although Crawford feels that she has agency to revise her units to integrate climate change, particularly once she closes her classroom door, she thinks it is not usually practical to be able to do such integrations effectively because "there is such a push that I need to get through everything by the end of the year." She checks what she covered with her school regions' official website who recently revised their curriculum per the NGSS. She also checks her objectives with her department's chair. In the same inter-view, Crawford also highlighted that there might be more flexibility that she is not yet aware of because she feels like she is "such a rule follower." Due to these demands about covering all the scientific topics, she feels like she needs to follow the units described by her school region. This curricu-lum currently focuses on three scientific disciplines: physics, chemistry, and biology, and does not touch climate change until eighth grade (the last year of middle school). She explained this on a recent interview as:

> In our curriculum, in grade sixth, seventh, eight like we have a little bit of chemistry in all three. A little bit of physics in all three. A little bit of bio in all three. There is a unit in grade eight that's called "overstepping our resources" and that is when they are starting real-ize like how, what they are doing is impacting everywhere else. This is an issue! Why isn't it sprinkled throughout, even if it's just the words, climate change is introduced like weather vs. climate you know. We don't do any of that in sixth or seventh grade. Like sprin-kling the topic starting at sixth grade so they won't be blindsided or not so ignorant once they do get to eight grade.

School Culture and the Lack of Administrative Support

Another challenge Crawford described was related to the lack of admin-istrative support. Although other scholars speculated that the political

controversy might lead to a lack of administrative support, in Crawford's case, the reason was different. The administrators at her school were focusing on language arts:

> Administration, because I feel as if when you don't have support from the administration, things can go south really quick and so if I like to have a specific climate initiative to happen in our school or if I get grant money to start some sort of initiative, if my administration is not on board, you know a program could go nowhere. My principal is more language arts based which means my head teacher is from a language arts classroom. So they are really focused on literacy right now. Now, it could be climate literacy, but if we are all about annotating like that's the kind of route they are going so I feel like as if I come from a strong science point of view. And if they don't really like see that as an importance.

Crawford, who comes with a strong scientific background, did not feel that administrators at her school gave importance to scientific issues.

Discussions and Further Implications

The study reported in this chapter is rooted within our own assumption and hope that teachers might serve as agents of change in relation to addressing issues connected to climate change in their classrooms. The analysis of ethnographic interviews, reflections, and other related artifacts showed a variance in Crawford's conceptualization of agency in her different roles such as a future teacher vs. a citizen of her community/town. Her sense of agency also evolved as she engaged in guided teaching practices of climate change in middle school classrooms. The findings explained how Crawford conceptualized agency in multiple contexts and across time. Driving from our intertextual analysis, we further elaborated on the reasons behind changes in her sense of agency.

Previous studies show that PSTs do not see themselves as capable of addressing climate change (e.g., Lee et al., 2012) which is seen as complex and (assumed to be) controversial (Sezen-Barrie, Shea, Borman, 2019). It is critical to prepare teachers for rigorous and equitable teaching of climate change for the next generations who will likely experience more of the already observed impacts of it. As Crawford noted, the middle school students will be the middlemen who will communicate climate change. Therefore, making climate change evidence and claims accessible to youth is necessary for intergenerational equity. This suggests that it is critical to have exposures to young students in preparation to teach climate change to help PSTs strengthen their sense of agency to feel powerful and to create impact in future classrooms. Other studies also highlighted the critical age of middle school youth in caring about

climate change (Stevenson, Peterson, Bondell, Moore, & Carrier, 2014). While working with the middle school age group, we also observed that middle school students' care for the environment was an important factor for the PST, Ms. Crawford, to develop a high feeling of agency in positioning her role in climate change solutions. Although Schindel and Tolbert's (2017) study showed that teachers' carework led to more engaged students, our study indicated that the impacts can be bidirectional. In other words, students' carework can engage their teachers to feel themselves to be important agents in solving the climate change problem.

Even though working with future generations makes it easier to notice the unfair problems or impacts these young people will experience, the uncertain aspects of climate change impacts remains a concern. Teachers do not have much experience in working with uncertainties in science classrooms. A few recent studies have worked on how to integrate productive uncertainty into science classrooms (e.g., Manz & Suárez, 2018). We see this line of research as particularly important for teacher education programs. Even though teachers like Ms. Crawford will develop strong agencies about teaching climate change due to the impact they see in youth, this will only be more sustainable if they can work with uncertainties related to climate change impacts.

The findings of the study also show that promoting epistemic agency in scientific activity reshaped Crawford's sense of agency to feel that the students can be the population she can work with. Seeing students figure out their designs or explanations was inspiring to her. Previous studies explored how fostering students' epistemic agency can result in better engagement and better learning outcomes (Eriksson & Lindberg, 2016; Zimmerman & Weible, 2018). We see the potential for increased student epistemic agency impacting teachers' agency to act on reform-based ideas, which was integrating climate change in this study. Therefore, we suggest that further studies can explore the impacts of increased epistemic student agency on teachers. We do nevertheless acknowledge that this suggestion is more applicable in similar sociopolitical contexts similar to the one that defined this study, where students' families are from the middle or upper-middle class who share mostly liberal political views. Previous work showed that climate change denial is a more serious problem in low income, agricultural communities, despite living and working in areas that will be more vulnerable to anthropogenic climate change impacts (Stevenson et al., 2018). Other researchers found that the political affiliations of farmers are the most influential factor in their perceptions of risks and prioritizing broad scale climate policy (Smith et al., 2014). Therefore, we maintain that it will be more challenging for PSTs to promote epistemic agency in climate change learning if they are working in geographies where conservative political views spread doubt about climate change.

At the opening of this section, we highlighted how Ms. Crawford sees that her individual actions or individual concerns seem ineffective in

tackling the climate change problem. She gives many examples of individual efforts such as "not using straws," "driving a small car," or "small scale environmental projects with her students." Wynes and Nicholas's (2017) study regarding climate change mitigation cautions us that not every strategy is high impact. Indeed, they found that many textbook recommendations (e.g., recycling) are low to moderate impacts. The top three strategies they found in their study were: (1) have one fewer child, (2) live car free, and (3) avoid long flights. More importantly, many ideas Crawford mentioned focused on what Chawla and Cushing (2007) would call a "private sphere" (individual or household). This is unfortunately the case in our own previous work as well (Sezen-Barrie, Miller-Rushing, & Hufnagel, 2019). Therefore, we suggest that teacher preparation programs should also focus on collective action in solutions to climate change. Some scholars suggest the integration of principles from humanities into science learning so that, while learning about climate change, we can also be educated about tax reforms, policies, investigating different opinions, and arguing expert opinions based on scientific evidence (Ignell, Davies & Lundholm, 2018; Lundholm, 2011).

Education is a means to access larger populations and create an informed citizenry, and empower the public to act towards solutions to climate change. Educational settings such as schools have the potential to create equitable learning experiences where students can explore scientific evidence behind climatic change. An important role of teachers is to address the intergenerational dilemmas of climate change and bring about social change. In order to realize these goals, however, there is still work that needs to be done through a systemic approach that includes teacher education, professional development, as well as school systems.

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